26) A method of forming a metal product having a cutting edge according to claim 17; wherein the metal product formed comprises one of an ice skate blade, snow ski edge, kitchen knife, pen tip and fishing hook.

Additional Fees:

Enclosed herewith kindly find a check for $295 to cover the costs of 5 claims in excess of 20, a two month extension for reply and a terminal disclaimer. No additional fees are believed to be required. However, should it be determined that any additional fees are due, please contact the undersigned attorney for immediate remittance of any such fees.

REMARKS

In the last Office Action, claims 17-19 were rejected under 35 USC 102(a) as being anticipated by Applicant's Admitted Prior Art ("AAPA"). Claims 1-16 and 20 were rejected under 35 USC 103(a) as being unpatentable over AAPA in view of US Patent 5,156,321 to Liburdi et al ("Liburdi"). Claims 1-20 were also rejected under the judicially created doctrine of obviousness-type double patenting as being upatentable over claims 1-31 of US Patent No. 6,049,978 ('978) and claims 1-22 of US Patent No. 5,956,845 ('845).

By this response, claim 13 has been cancelled. Claims 1-12 and 17–20 have been amended to more fully distinguish the claimed invention over the prior art. New claims 21- 26 have been added.

As described in the specification for example at pages 23-26, a method of forming a metal product having diffusion bonding occurring between a metal substrate and an applied coating is provided. This diffusion bond is superior to the bond obtained from conventional metal product forming methods, and enables the formation of a metal

product having superior surface characteristics. The first step of the inventive method is to determine the attributes of a final workpiece product. For example, if the final workpiece product is a cutting tool the attributes include a wear resistant surface formed on a relatively inexpensive tool substrate. An appropriate substrate composition is then determined depending on the selected attributes. In the example of a cutting tool, the substrate composition may be high speed steel, which is relatively inexpensive to form but durable enough for its intended purpose. A workpiece substrate is formed to near-finished dimensions, using known processes such as casting, extruding, molding, machining, etc. An appropriate coating material composition is determined depending on the selected attributes. Again, in the example of a cutting tool, the coating material could be selected from a number of relatively hard and durable metals and alloys such as Cobalt, Carbide, TiN, etc. The selection of both the substrate and coating composition also depends on their metallurgical compatibility with each other.

The coating material is built-up to a thickness that is effective to obtain desired finished dimensions after performing a hot isostatic pressing treatment. The high-density coating process may comprise performing a hyper velocity oxy-fuel thermal spray process. In the case of HVOF, a fuel gas and oxygen are used to create a combustion flame at 2500 to 3100°C. However, the HVOF process forms a bond between the coating material and the substrate that occurs primarily through mechanical adhesion at a bonding interface. As will be described below, in accordance with the present invention this mechanical bond is converted to a metallurgical bond by creating a diffusion bond between the coating material and the workpiece substrate. This diffusion bond does not have the interface boundary which is usually the site of failure. Further, the coating process typically entraps gas within the coating. This entrapped gas tends to be driven out of the coating during the subsequent HIP process and results in an undesired bubbled surface texture in the final product. In accordance with the present invention, a sintering

heat is employed prior to the HIP process to remove the entrapped gasses. The result is a post-HIP product that has superior surface characteristics, along with a very strong diffusion bonding between the coating material and the substrate.

Thus, in accordance with the present invention, the HIP treatment process is performed on a HVOF coated substrate to convert the adhesion bond, which is merely a mechanical bond, to a diffusion bond, which is a metallurgical bond. In accordance with the present invention, an HVOF coating process is used to apply the coating material having sufficient density to effectively undergo the densification changes that occur during the HIP process. After the HVOF spray material is applied, a sintering heat treatment process is performed to further densify the coating to prevent gas entrapment of the coating material and/or the diffusion bonding area during the hot isostatic pressing process.

Further, as shown in Figures 2(a) through 2(d), the inventive method can be used for forming, a cutting tool having a wear resistant surface. The inventive method can be employed to produce, for example, a long lasting cutting tool from a relatively inexpensive cutting tool substrate 10. For example, the tool substrate 10 may be a drill bit, end mill, lathe tool bit, saw blade, planer knifes, cutting tool inserts, or other cutting tool part. The substrate may, alternatively, be something other than a tool. For example, ice skate blades and snow ski edges may be treated in accordance with the present invention to obtain a long wearing edge. Kitchen knives may be treated in accordance with the present invention to reduce the need for constant sharpening. Further, products such as pen tips and fishing hooks may be treated in accordance with the present invention so as to benefit from long lasting durability (see, for example, pages 57 – 60 of the present specification).

In accordance with the present invention, a method is provided for forming a metal product having a cutting edge having a wear resistant surface. A workpiece substrate is provided having a cutting edge portion. A high-density coating process is used to coat at least the cutting edge portion of the workpiece substrate with a wear resistant coating material. A hot isostatic pressing treatment is performed on the coated workpiece substrate to obtain a metal product having a wear resistant surface comprised of the coating material. The wear resistant surface is formed at the cutting edge portion and has a diffusion bonding between the coating material and the workpiece substrate. Thus, in accordance with the present invention, a metal product can be formed that has a cutting edge made of a long lasting, durable material that is diffusion bonded to a formed substrate.

By this invention, for example, a long lasting drill bit can be formed having a superior cutting edge integrally bonded to a preformed drill bit substrate. It often may not be practical to form the substrate out of the same material as the cutting edge. For example, high speed steel is a durable and relatively inexpensive material to use as a drill bit substrate, but does not hold a sharp cutting edge during use. A Cobalt, Carbide, TiN coating can be used to greatly improve the durability and usefulness of the cutting edge. Typically, such a coating will eventually flake or scrape off from the substrate. However, in accordance with the present invention, the cutting edge has an integrally formed durable coating that is diffusion bonded to the substrate and is not susceptible to cracking or flaking off. Further, in accordance with the present invention, a sintering heat treatment can be performed on the coated workpiece substrate to remove entrapped gas in the coating material prior to performing the HIP treatment. This sintering step ensures that the final surface texture of the finished formed metal product will be relatively smooth, which is particularly important with regard to the use of the formed metal product for a cutting tool.

Claims 17 – 19 were rejected as being anticipated by AAPA. The claims have been amended to specifically define the inventive method for forming a metal product having a cutting edge with a wear resistant surface. AAPA reference various methods for repairing metal products. In accordance with the amended claims, a formed metal product having a very durable cutting surface integrally formed with the product substrate is obtained. As defined in the newly added claims, this durable cutting surface can thus be obtained for a variety of applications, including cutting tools, such as drill bits and end mills, sports equipment, such as ice skates and skis, kitchen knifes, pen tips and fishing hooks. Applicant respectfully submits that the inventive method for forming a metal product having a durable cutting edge is not anticipated by the AAPA.

Claims 1-16 and 20 were rejected as being obvious in view of AAPA and Liburdi. The examiner recognizes that AAPA does not mention the step of performing the sintering heat treatment prior to the HIP treatment. The examiner states that Liburdi discloses performing a sintering heat treatment prior to HIP. However, applicant respectfully points out that Liburdi teaches that a part is held at a temperature for sufficient time for partial solid state sintering to occur. Liburdi defines solid state sintering as a process by which particles in a powder mass or compact are consolidated by sold state and surface diffusion, wherein the power remains solid. Partial solid state sintering results in a porous structure which is less than 100% dense (see, col. 3, lines 60 to 66).

As described in the specification, on the other hand, in accordance with the present invention sintering is performed specifically to *prevent* a porous structure. In accordance with the present invention, a sintering heat treatment is performed to improve the density of the coating material and prevent gas entrapment during hot isostatic pressing treatment. Applicant has discovered that the existence of gas entrapped within the coating material during the HVOF coating process will tend to be driven out during

the subsequent HIP process (see, for example, specification page 27, lines 6 – 8). This entrapped gas creates a very undesirable bubbled surface texture in the final workpiece. Often, this bubbled surface texture will make the final workpiece not usable for its intended use.

Through direct experimentation, applicant has discovered that performing the sintering heat treatment step in accordance with the present invention overcomes this major drawback. Liburdi, in direct contrast, teaches away from the present invention by teaching that the partial solid state sintering process results in a "porous" structure. This is precisely the internal structure of the coating material that applicant's sintering process avoids.

To further define the claimed invention over the prior art, the claims have been amended so that it is clear that the sintering step is performed prior to the HIP step so as to remove entrapped gas in the coating material. As claimed the present invention can be used to create a metal product having a superior cutting edge. Of course, to be effective the cutting edge of the metal product formed in accordance with the present invention has to have a relatively smooth surface. That is, it is undesirable for the cutting edge surface to have bubbles at the end of the product forming process. It is also undesirable for the coating material to have the "porous" structure taught be Liburdi. Rather, as disclosed in the present specification, the sintering heat treatment is performed so that the coating material is densified, so as to drive out entrapped gas. This entrapped gas is thus removed from the workpiece surface before the HIP treatment and the bubbling defect is avoided, while still obtaining the very desirable result of having a formed metal product with a cutting edge having a diffusion bonded wear resistant coating. The inventive method is not disclosed or suggested by any of the prior art. Accordingly, applicant respectfully submits that the rejection based on obviousness has been overcome.

Claims 1-20 were rejected under the judicially created doctrine of double patenting as being unpatentable over Applicant's prior US Patents '978 and '845. Accordingly, applicant submits herewith completed USPTO Form PTO/SB/26 for each of the prior patents. Accordingly, the rejection based on double patenting is believed to have been overcome.

Accordingly, applicant respectfully submits that the claims of the present application are allowable over the prior art. In view of the foregoing, favorable reconsideration and allowance of the claims of the application are most respectfully requested. The Examiner is invited to contact the undersigned by telephone if there are any questions or suggestions regarding the present application.

Respectfully submitted,

September 4, 2001

John J. Daniels, Reg. No. 34,808

511 Foot Hills Road

Higganum, CT, 06441

(860) 345-4734

MAILING CERTIFICATE

Date of Deposit: 9/10/01

I hereby certify that this correspondence is being deposited with the United States Postal Service as "First Class Mail" on the date indicated above in an envelope addressed to: Commissioner of Patents and Trademarks, Washington, D.C. 20231.

John J. Daniels

Reg. No. 34, 808